

WHAT IS CLAIMED IS:

- 1 1. A method for generating a portion of an image, the method comprising:
2 receiving an identification of a modification region in an original image;
3 calculating a differential representation of an image texture region;
4 calculating a differential representation of boundary pixels in the original image,
5 wherein at least some of the boundary pixels are outside of and adjacent to the
6 modification region;
7 generating new differential pixel values for the modification region using the
8 differential representation of the image texture region to obtain substantial consistency
9 with the differential representation of the boundary pixels; and
10 integrating the new differential pixel values to obtain a modified image.
- 1 2. The method of claim 1 further comprising using the modified image as a replacement for
2 the modification region of the original image.
- 1 3. The method of claim 1 further comprising receiving an indication of an area in the
2 original image that comprises the image texture region.
- 1 4. The method of claim 3 wherein the image texture region is derived from a portion of the
2 original image that overlaps at least one of the modification region and the boundary
3 pixels.
- 1 5. The method of claim 1 further comprising receiving an indication of an area in an image,
2 other than the original image, that comprises the image texture region.
- 1 6. The method of claim 1 wherein calculating a differential representation comprises
2 determining derivatives using a predefined kernel.
- 1 7. The method of claim 6 wherein calculating a differential representation comprises
2 calculating a multi-channel differential representation.

- 1 8. The method of claim 1 wherein calculating a differential representation comprises
2 calculating at least a second order differential representation.
- 1 9. The method of claim 1 wherein generating new differential pixel values comprises
2 performing texture synthesis to obtain a substantially consistent texture between the
3 differential representation of the boundary pixels and the new differential pixel values.
- 1 10. The method of claim 9 wherein performing the texture synthesis comprises using samples
2 of the differential representation of the image texture region to generate the new
3 differential pixel values starting from the differential representation of the boundary
4 pixels.
- 1 11. The method of claim 1 wherein the new differential pixel values collectively form a new
2 differential representation for the modification region.
- 1 12. The method of claim 11 wherein integrating the new differential pixel values to obtain the
2 modified image comprises iteratively applying at least one kernel to generate a solution
3 to a partial differential equation having a source term corresponding to the new
4 differential representation of the modification region.
- 1 13. The method of claim 12 wherein the partial differential equation comprises a Poisson
2 differential equation.
- 1 14. The method of claim 13 wherein the boundary pixels in the original image provide
2 Dirichlet boundary conditions for the Poisson differential equation.
- 1 15. The method of claim 11 wherein the new differential representation for the modification
2 region has an original resolution, wherein integrating the new differential pixel values to
3 obtain a modified image comprises:
4 resampling the original-resolution new differential representation of the modification
5 region to a lower-resolution new differential representation of the modification region;

6 calculating new lower-resolution pixel values for the modification region by
7 iteratively applying at least one kernel to generate a solution to a partial differential
8 equation having a source term corresponding to the lower-resolution new differential
9 representation of the modification region;

10 resampling the new lower-resolution pixel values for the modification region to the
11 original resolution to produce approximate original-resolution pixel values; and

12 calculating new original-resolution pixel values for the modification region by
13 starting from the approximate original-resolution pixel values and by iteratively applying
14 at least one kernel to generate a solution to a partial differential equation having a source
15 term corresponding to the original-resolution new differential representation of the
16 modification region.

1 16. The method of claim 1 further comprising separating the original image into multiple
2 channels, wherein calculating the differential representation of the image texture region,
3 calculating the differential representation of the boundary pixels, generating the new
4 differential pixel values, and integrating the new differential pixel values to obtain a
5 modified image are performed for each of the multiple channels.

1 17. The method of claim 1 further comprising receiving an indication of a plurality of areas
2 in the original image that collectively comprise the image texture region.


- 1 18. A method for modifying an image, the method comprising: ✓
2 calculating a differential representation of at least a portion of an original image;
3 calculating a differential representation of at least a portion of a texture source image;
4 performing texture synthesis using samples of the texture source image differential
5 representation, wherein texture synthesis is performed starting from a boundary of the
6 original image differential representation and performing the texture synthesis generates a
7 synthesized differential representation; and
8 generating a modified image from the synthesized differential representation by
9 solving a partial differential equation.
- 1 19. The method of claim 18 wherein the calculated differential representations are of a type
2 selected from a group consisting of a gradient, a Laplacian, a gradient of the Laplacian,
3 and a second Laplacian.
- 1 20. The method of claim 18 wherein the partial differential equation comprises a Poisson
2 differential equation having a form selected from the group consisting of $\Delta f = \nabla \cdot s$,
3 $\Delta f = s$, $\Delta \Delta f = \nabla \cdot s$, and $\Delta \Delta f = s$, where s corresponds to the synthesized differential
4 representation.
- 1 21. The method of claim 18 wherein a boundary of the synthesized differential representation
2 matches the boundary of the original image differential representation.
- 1 22. The method of claim 18 wherein the solution to the partial differential equation satisfies a
2 Dirichlet boundary condition provided by a portion of the original image.
- 1 23. The method of claim 18 wherein solving the partial differential equation comprises
2 iteratively applying at least one kernel and the synthesized differential representation to a
3 selected starting image.
- 1 24. The method of claim 18 wherein the texture source image comprises a region in the
2 original image.

- 1 25. An article comprising a machine-readable medium storing instructions for causing one or
2 more processors to perform operations comprising: /
3 receiving an identification of a modification region in an original image;
4 calculating a differential representation of an image texture region to produce
5 differential texture pixel values;
6 calculating a differential representation of boundary pixels in the original image to
7 produce differential boundary pixel values, wherein at least some of the boundary pixels
8 are outside of and adjacent to the modification region;
9 generating new differential pixel values for the modification region using the
10 differential texture pixel values to obtain substantial consistency with the differential
11 boundary pixel values; and
12 integrating the new differential pixel values to obtain a modified image.
- 1 26. The article of claim 25 wherein the machine-readable medium stores further instructions
2 for causing one or more processors to perform operations comprising using the modified
3 image as a replacement for the modification region of the original image.
- 1 27. The article of claim 25 wherein the machine-readable medium stores further instructions
2 for causing one or more processors to perform operations comprising receiving an
3 identification of at least one image texture area, wherein the image texture region
4 comprises the at least one identified image texture area.
- 1 28. The article of claim 25 wherein calculating the differential representation of the image
2 texture region and calculating the differential representation of the boundary pixels
3 comprises determining derivatives using at least one predefined kernel.
- 1 29. The article of claim 25 wherein generating new differential pixel values for the
2 modification region comprises generating a differential texture pattern that matches a
3 differential texture pattern of the image texture region.

1 30. The article of claim 25 wherein integrating the new differential pixel values to obtain the
2 modified image comprises iteratively applying at least one kernel to generate a solution
3 to a partial differential equation having a source term corresponding to the new
4 differential representation of the modification region.

1 31. The article of claim 30 wherein integrating the new differential pixel values to obtain the
2 modified image comprises iteratively integrating differential pixel values at progressively
3 higher resolutions beginning at a low resolution.

1 32. The article of claim 25 wherein the original image, the image texture region, and the
2 modified image correspond to one channel of a multiple channel image.

1 33. A method for modifying an image, the method comprising: 
2 receiving an identification of a modification region in an original image;
3 determining a boundary region in the original image, wherein the boundary region is
4 adjacent to the modification region;
5 performing texture synthesis in differential space using the boundary region to
6 produce a synthesized differential representation for the modification region; and
7 integrating the synthesized differential representation to generate a modified image.

1 34. The method of claim 33 wherein integrating the synthesized differential representation
2 comprises calculating a solution to a partial differential equation having a source term
3 corresponding to the synthesized differential representation.

1 35. The method of claim 34 wherein the partial differential equation comprises a Poisson
2 differential equation.

1 36. The method of claim 35 wherein performing texture synthesis in differential space
2 comprises:
3 calculating a Laplacian of the boundary region to produce differential boundary pixel
4 values;
5 calculating a Laplacian of a texture region to produce differential texture pixel values;
6 and
7 selecting samples of the differential texture pixel values for use in generating the
8 synthesized differential representation.

1 37. The method of claim 33 wherein performing texture synthesis comprises selecting
2 samples from a texture image that match the boundary region in differential space.

1 38. The method of claim 37 wherein the texture image corresponds to a differential space
2 representation of a texture region in the original image.

- 1 39. A method for generating a modified image, the method comprising:
2 receiving an identification of a modification region in an original image;
3 calculating a differential representation of at least a portion of a texture source image;
4 copying samples of the texture source image differential representation to a location
5 corresponding to the identified modification region to generate a new differential
6 representation for the modification region; and
7 integrating the new differential representation for the modification region to produce
8 a modified image.
- 1 40. The method of claim 39 further comprising using the modified image as a replacement
2 for the modification region of the original image.
- 1 41. The method of claim 39 wherein the samples of the texture source image differential
2 representation are copied to a location within a differential representation of at least a
3 portion of the original image.
- 1 42. The method of claim 39 further comprising receiving an identification of the texture
2 source image, wherein the texture source image comprises a portion of the original
3 image.
- 1 43. The method of claim 39 further comprising receiving an identification of the texture
2 source image, wherein the texture source image comprises at least a portion of a different
3 image from the original image.
- 1 44. The method of claim 39 wherein copying samples of the texture source image differential
2 representation to a location corresponding to the identified modification region comprises
3 filling a region corresponding to the identified modification region with samples of the
4 texture source image differential representation.
- 1 45. The method of claim 44 wherein multiple different samples are available in the texture
2 source image differential representation.

3 46. The method of claim 39 wherein integrating the new differential representation for the
4 modification region to produce a modified image comprises calculating a solution to a
5 partial differential equation.

1 47. The method of claim 46 wherein integrating the new differential representation for the
2 modification region to produce a modified image comprises using a boundary region
3 adjacent to the modification region in the original image to provide boundary conditions
4 for calculating the solution to the partial differential equation.

1 48. A method for modifying an image, the method comprising: /
2 receiving an identification of a modification region in an original image;
3 determining a rate of change between pixels across a region of a texture source
4 image;
5 applying the rate of change to the modification region; and
6 determining new pixel values for the modification region that exhibit the rate of
7 change and that exhibit consistency with boundary pixel values adjacent to the
8 modification region in the original image.